Secretary by Mr. William Summerhayes, dated Aroa, Venezuela, February 19, 1874:—

"I have read carfully your Monograph on the Cracidæ: there is no doubt of the correctness of your identification of both *Crax daubentoni* and *Pauxi galeata*.

"I have shot specimens of both kinds in this neighbourhood, and compared them diligently with your Latin descriptions, on the accuracy of which I beg to compliment you. The *Crax daubentoni* is found here all along the littoral as far as the foot of the mountains (here some 50 or 60 miles inland); but as soon as you get among the mountains (and these mines, whence I write, are only some 5 miles up the Sierra and away from the forest which clothes the littoral flat country) you see no more of the *C. daubentoni*, but numerous specimens of *Pauxi galeata*."

The following papers were read:—

1. On the Nature of the Sacs vomited by the Hornbills. By Dr. James Murie, F.L.S.

[Received May 9, 1874.]

Lapse of time has not erased from my memory the puzzled countenance, not to say blank dismay, of my friend Mr. A. D. Bartlett, on my announcing to him my conclusions respecting the nature of a fig-like envelope containing discoloured grapes, which he suspected had been thrown up by the Wrinkled Hornbill, *Buceros corrugatus*. His alarm for the safety of the bird was converted into mirth at my expense, as a few days afterwards, he returned with a second specimen ejected from the same bird. The latter, it would seem then, was none the worse for losing *the interior lining of his stomach*, and in the interval had made a new one and got rid of it also.

I certainly, at the time, was not prepared for the full extent of the phenomenon. But I felt satisfied from my examination that the sac was not what is ordinarily regarded as a secretion (namely, glandular product), but rather was of an epithelial horny kind—the veritable gizzard-lining itself, howsoever reproduced.

In Mr. Bartlett's cleverly reasoned paper, P. Z. S. 1869, p. 143, an abstract of my report to him is given. He opposed the notion of the rejected sac being a true gastric lining, and held to its being a secretion provided for and emitted during the breeding-season. He regarded it as of a nature similar in kind to the proventricular secretion of incubating Pigeons, Parrots, &c. As to its greater solidity and gizzard-membrane characters, these he deemed producible by that viscus, and to be analogous to the gastric mouldings of the indigestible pellets cast up by the Raptorial and Insessorial birds. At the discussion on the paper my statement of the sac being the epithelial coating of the gizzard was received incredulously.

The sac and its contents, and subsequently the viscera of the bird itself, which died shortly after, were consigned to the College-of-Sur-

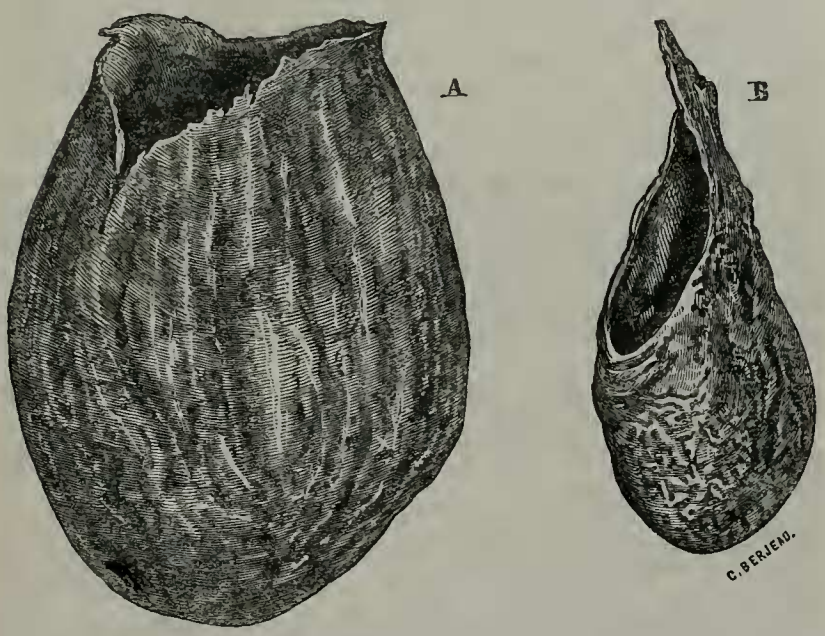
geons' Museum, and mounted as preparations. Professor Flower carefully examined and compared the above.

In his notice of the object (P. Z. S. 1869, p. 150) he found the stomach possessing its apparent natural coat. Whence, therefore, had the other come? He confirmed my statement of the identity in structure of the expelled sac and the internal epithelial layer of the cavity of the gizzard. Both behaved the same to chemical reagents; microscopical sections of each exhibited a like matrix slightly laminated with scattered nuclei and granules. He failed, however, in either to detect the definite structures ascribed to the inner coat of graniferous birds.

There still remain some obscure and hitherto unexplained points connected with the production of these anomalous food-bags, which it is the purport of the present paper to unravel. However incongruously it may sound, Mr. Bartlett and myself were both right and both wrong—he correct in suspecting the substance to be a periodical regurgitation normally coincident with the process of incubation, in error in believing it to be a secretion derived from the proventriculus or glands opening into the alimentary canal above that. I was justified in its being the epithelial layer of the gizzard, but deceived as to its being cast off through morbid influences.

From indubitable evidence on the habits of the wild birds and frequent occurrence of the phenomenon in specimens in the Society's Menagerie, as described by Mr. Bartlett, there is validity in assuming that the vomiting of food enclosed in a horny sac is common to

Fig. 1.



Empty gizzard-sacs ejected by the Subcylindrical Hornbill, *Buceros subcylindricus*; about natural size.

the Hornbill group, the undermentioned instance (occurring in an African species now alive in the Gardens) substantiating such a view.

The accompanying woodcut (fig. 1, A) illustrates the exterior appearance of one of the objects in question. Its history is as follows:—"This case was thrown up by the Subcylindrical Hornbill (*Buceros subcylindricus*, Sclater), August 5th, 1872. The bird had commenced to peck it to pieces and eat the fruit it contained at the time it was thrown up. The keeper caught the bird (a male) in the act of eating it." The drawing (fig. 1, B) represents another of the sacs, which, as I was informed, came from the same bird, but was cast up at a later date, the precise date not being noted. Both retain, pretty correctly, the rugose character observable when freshly expelled, although they were kept in spirits prior to being sketched. That lettered A is much larger than B, on account of the contained food having been removed and cotton in sufficient quantity replaced, so as to prevent undue shrinkage. It is therefore of tolerably natural dimensions. The fruit enclosed within B was left in place; but it, as well as the wall-membrane, had contracted very considerably from its original size. The contrast between the two is instructive as showing behaviour virtually the counterpart of the corneous gastric texture; and this similarity of tissue is confirmed when a portion is dried, it then becoming translucent and brittle.

It would be superfluous for me to say more concerning the external aspect and contents of these figured sacs, other than that they agree in every particular with Mr. Bartlett's, Professor Flower's, and my own descriptions already published—with the exception that the smaller one contained, in addition, a gooseberry. Their intimate microscopic texture is of more consequence, and, as I apprehend, affords a clue to the solution of the problem. For this reason I have been particular in making accurate sketches under different magnifying-powers.

I may premise by stating that certain portions of the tissue of the two sacs differ in one essential particular, this very discrepancy, however, elucidating and tiding over a difficulty. In brief, it most conclusively demonstrates that the constituents, at this part at least, can be no other than the entire thickness of the horny layer of the gizzard. According to the researches of Molin*, Flower†, Hasse‡, and others§, the inner coat of the gizzard in various orders and

* "Sugli stomachi degli uccelli," in Denkshr. d. Acad. zu Wien, 1852, vol. iii. pt. 2, p. 1, tab. i.–iv. A well-illustrated investigation.

† "On the structure of the Gizzard of the Nicobar Pigeon and other Granivorous Birds," P. Z. S. 1860, p. 330, pls. 175, 176. Substantiates the conclusions of the foregoing author.

‡ "Beiträge zur Histologie des Vogelmagens," Zeitsch. f. ration. Med. vol. xxviii. p. 1. As bearing on the question of bird-secretions, see also his paper, "Ueber den Œsophagus der Tauben, &c.," Henle and Pfeuffer's Zeitsch. vol. xxiii. p. 101. Also Bergmann "Einiges über den Drüsenmagen der Vögel," Reich. & D. B. Reymond's Archiv, 1862, p. 581.

§ Berlin, in Ned. Lanc. July and Aug. 1852, quoted by Kölliker; but the original article I have not seen. Leydig, in his 'Histologie,' p. 309, gives an en-

families of birds (*strato epiteliale*, Molin) is composed of a corneous, and, in thin slices, pale yellow transparent substance. The lower surface of this lies upon the subjacent follicular layer (Flower), the former dovetailing with the papillæ of the latter. As the horny layer ascends it exhibits a series of vertical, parallel, and cylindrical columns, each homogeneous in composition and with intervening epithelio-granular substance. Towards the free surface the columnar character ceases, and is replaced by loosely arranged epithelium-scales. In some genera of birds the columns are found to be tolerably regular and equidistant; in others they are more unequally distributed or form aggregated groups.

A portion, though, I find, (not the whole) of the large sac obtained from the Subcylindrical Hornbill corresponds in its minute structure with the above description in every particular. In the vertical section (A, fig. 2, p. 424), and more highly magnified portion of the same (B), short tubular prolongations are observed inferiorly. These, in some instances, have a compound character terminally, while optically deeper or beyond them others similar in kind are visible. By different focusing of the object, a granular and partly fibro-cellular thin connective layer is seen, moreover, to invest the tubes just above their free ends. This produces an appearance suggestive of the lower extremities, seeming tubules, being short, compound, granular flasks, which decidedly they are not, but only the unequal extension of the homogenous pillars above mentioned. These latter, in this perpendicular view, are long rods barely to be distinguished from the intermediate substance, on account of the latter being less transparent. At different levels, more defined indications of horizontal stratification or lamellar layers obtain. At the top of the rods there is a copious development of large nucleated and granular columnar epithelium. Here and there also some of the tubules have been squeezed out, and, along with the narrow ends of epithelial scales, present an irregular fringed margin. In the horizontal sections of the same object (C, D, E), the solid nature of the rods is manifest, and it becomes abundantly evident that several rods (averaging 4 to 5) lying in apposition constitute a column or cylindrical bundle. These latter are dispersed at tolerably equidistance, though not precisely regular in contour or calibre; and this causes a grade or variety in the pattern. From the difficulty of cutting a perfectly flat, uniform section, a partly tangental one occasionally results; but this more clearly shadows forth the coalescence of the homogeneous rods, and how their aggregation into pillars is effected. At other places it likewise admits of the molecules and nucleolar-celled character of the intercolumnar tissue being studied.

With regard to the other smaller sac, I have not been fortunate in my search to obtain tissue answering to the above cylindroid character, but find it simpler or less differentiated in its elements, agree-

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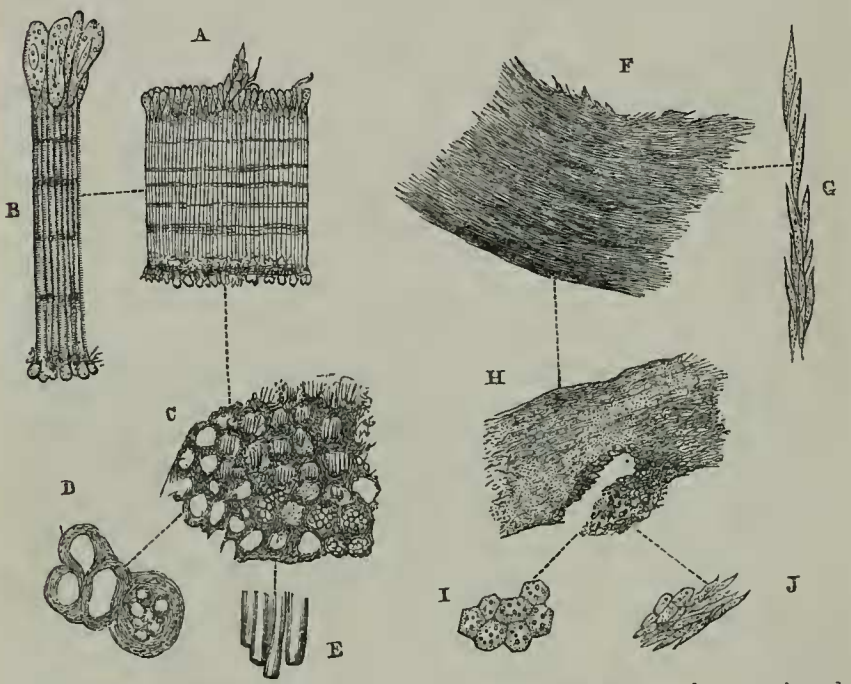
larged vertical section through all the coats of the stomach of the Heron, which well enables the relations of the strata to one another to be studied. Klein, in his articles "Œsophagus" and "Stomach" in Stricker's 'Manual,' pp. 536 & 554.

ing nevertheless with parts, other than that above described, of the large sac. The most notable and obvious distinction, then, consists in the absence of the homogeneous pillars and therefore looped network of intermediate substance. Instead of these, there are but continuous wavy and horizontally stratified layers of epithelium and

Fig. 2.



Illustrations of the microscopical tissues and elements forming the sacs ejected by the Subcylindrical Hornbill.

A. Vertical section, through the entire thickness of the part, exhibiting upright cylinders, inferior prolongations, and superior free columnar epithelium.
B. Small piece of the same, more highly magnified.
C. Horizontal section from about the middle of A, displaying the cylinders or aggregate rods both somewhat obliquely and when cut straight across; together with the intermediate substance or epithelio-granular meshwork.
D. Still further enlarged piece of the same section.
E. Protruding cylinder of rods, very considerably magnified.
F. Vertical section (corresponding to A), showing no cylindrical arrangement, but wavy stratified layers of an epithelial character.
G. Partial layer of its epithelium under a higher power, but transposed uprightly.
H. Horizontal section from about the middle of E, showing absence of the cylinders and that it is composed of epithelium and nucleolar corpuscles in various stages of development.
I. Some of the polygonal or tessellated, horny, nucleated scales of H, enlarged.
J. Another view of the epithelium, showing transition from oval to elliptical character.

granules of various stages of development throughout its entire thickness. These, moreover, appear to be piled in tiers, marked by